WE CLAIM

1.   A transcoder, said transcoder comprising:

a)   a frame buffer;

b)   an encoder receiving input from said frame buffer;

c)   a vbv buffer receiving input from said encoder;

d)   a channel interface receiving input from said vbv buffer;

e)   a channel rate control connected to said vbv buffer and said channel interface; and

f)   a transcoder rate control connected to said frame buffer, said encoder, said vbv buffer and said channel rate control.

2.   The transcoder of claim 1 further comprising a decoder to provide input to said frame buffer.

3.   The transcoder of claim 1 wherein said channel rate control monitors the fullness of said vbv buffer and controls the output of said vbv buffer to meet a target bit rate in transmitting data to said channel interface.

4.   The transcoder of claim 3 wherein said transcoder rate control monitors the contents of said frame buffer and said vbv buffer to ensure said vbv buffer does not underflow nor overflow, said transcoder rate control using the results of said monitoring to control the rate at which frames are extracted from said frame buffer, encoded by said encoder and sent to said vbv buffer.

5.   The transcoder of claim 4 wherein said transcoder rate control utilizes rate reduction means to achieve a target bit rate, said target bit rate being the rate at which data is provided from said vbv buffer to said channel interface.

6.   The transcoder of claim 5 wherein said transcoder rate control further comprises requantization means, said requantization means selectively requantizing the transform coefficients of the macroblocks of a frame based upon image quality degradation.

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7.   The transcoder of claim 1, wherein said transcoder rate control modifies the quantizer scale of macroblocks in frames transmitted from said vbv buffer to said channel interface.

8.   The transcoder of claim 1, wherein said transcoder rate control inserts a vbv delay value for frames transmitted by said channel interface.

9.   A method of controlling the rate of an MPEG video stream to achieve a target bit rate, said method comprising the steps of:

    a)   computing a rate reduction factor;

    b)   computing a quantizer scale;

    c)   applying the results of steps a) and b) to an encoder to achieve said target bit rate; and

    d)   repeating steps a) to c) for a plurality of frames in said video stream.

10.   The method of claim 9 wherein step a) comprises the steps of:

    i)   setting said rate reduction factor to and a rate increase variable to 0;

    ii)   adding the size of a current frame in a frame buffer to a total size variable;

    iii)   adding the duration of the current frame to a total delays variable;

    iv)   calculating a current value of the number of bits in a vbv buffer;

    v)   if the current value of the number of bits in the vbv buffer is less than a lower threshold, increasing said rate reduction factor;

    vi)   if the current value of the number of bits in the vbv buffer is greater than an upper threshold, increasing said rate increase variable; and

    vii)   repeating steps ii) to vi) for a plurality of frames in a said frame buffer.

11.   The method of claim 10 wherein step a) further comprises the steps of:

    viii)   calculating a rate reduction factor for the current frame if needed, otherwise setting a value for a channel bit rate.

12.   The method of claim 10 wherein step b) further comprises the steps of:

        i)   calculating a cumulative distribution function for each macroblock in a current frame;

        ii)   initializing a quantizer multiplier array;

        iii)   setting the quantizer scale for each macroblock in the current frame;

        iv)   calculating a quantizer multiply for each macroblock in the current frame; and

        vi)   setting a quantizer scale code for each macroblock in the current frame.

13.   A video encoding system, said system accepting as input a source stream and outputting a modified stream, said system comprising means to determine the amount of rate reduction necessary to achieve a target bit rate for said modified stream.

14.   The system of claim 13 further comprising means to compute vbv buffer occupancy and means to compute rate reduction based on said target bit rate.

15.   The system of claim 14 further comprising means to requantize transform coefficients of the macroblocks in a frame.

16.   The system of claim 15 wherein said output video stream contains a new quantizer scale for each macroblock of each frame as calculated by said means to requantize.

17.   The system of claim 14, wherein said system may insert a new vbv delay for each frame contained in said output video stream.

18.   A computer readable medium containing instructions for controlling the rate of an MPEG video stream to achieve a target bit rate, said instructions performing the steps of:

        a)   computing a rate reduction factor;

        b)   computing a quantizer scale;

        c)   applying the results of steps a) and b) to an encoder to achieve said target bit rate; and repeating steps a) to c) for a plurality of frames in said video stream.

19.   The medium of claim 18 wherein step a) comprises the steps of:

        i)   setting said rate reduction factor and a rate increase variable to 0;

        ii)   adding the size of a current frame in a frame buffer to a total size
variable;

        iii)   adding the duration of said current frame to a total delays variable;

        iv)   calculating a current value of the number of bits in a vbv buffer;

        v)   if the current value of the number of bits in the vbv buffer is less than a
lower threshold, increasing said rate reduction factor;

        vi)   if the current value of the number of bits in the vbv buffer is greater
than an upper threshold, increasing said rate increase variable; and

        vii)   repeating steps ii) to vi) for a plurality of frames in said frame buffer.

20.   The medium of claim 19 wherein step a) further comprises the step of:

        viii)   calculating a rate reduction factor for said current frame if needed,
otherwise setting a value for a channel bit rate.

21.   The medium of claim 18 wherein step b) further comprises the steps of:

        i)   calculating a cumulative distribution function for each macroblock in a
current frame;

        ii)   initializing a quantizer multiplier array;

        iii)   setting the quantizer scale for each macroblock in a current frame;

        iv)   calculating a quantizer multiply for each macroblock in the current
frame; and

        vi)   setting a quantizer scale code for each macroblock in the current frame.

22.   A system for controlling the rate of an MPEG video stream to achieve a target
bit rate, said system comprising:

        a)   means for computing a rate reduction factor;

        b)   means for computing a quantizer scale;

        c)   means for applying the results of steps a) and b) to an encoder to
achieve said target bit rate.

23.   The system of claim 22 wherein means for computing a rate reduction factor comprises:

   i)   means for setting said rate reduction factor and a rate increase variable to 0;

   ii)   means for adding the size of a current frame in a frame buffer to a total size variable;

   iii)   means for adding the duration of the current frame to a total delays variable;

   iv)   means for calculating a current value of the number of bits in a vbv buffer;

   v)   means for increasing said rate reduction factor if the current value of the number of bits in the vbv buffer is less than a lower threshold; and

   vi)   means for increasing said rate increase variable if the current value of the number of bits in the vbv buffer is greater than an upper threshold.

24.   The system of claim 23 wherein said means for computing a rate reduction factor further comprises:

   vii)   means for calculating a rate reduction factor for said current frame if needed, otherwise setting a value for a channel bit rate.

25.   The system of claim 22 wherein said means for computing a quantizer scale comprises:

   i)   means for calculating a cumulative distribution function for each macroblock in a current frame;

   ii)   means for initializing a quantizer multiplier array;

   iii)   means for setting the quantizer scale for each macroblock in the current frame;

   iv)   means for calculating a quantizer multiply for each macroblock in the current frame; and

   vi)   means for setting a quantizer scale code for each macroblock in the current frame.

Appendix 1

cdf [ ]	cumulative distribution function, specifically the cdf of quantizer_scale_code for all macroblocks in a frame
cdf_max	cdf_max is the maximum value of cdf at which rate reduction is no longer necessary, i.e. macroblocks having a higher quantizer_scale_code than that of cdf_max do not get their quantizer_multiplier incremented
channel_bit_rate	The value of channel_bit_rate is the bit rate at which the transcoder transmits the reformatted stream to an output channel. The value of channel_bit_rate is always less or equal to target_bit_rate.
delays [ ]	The value of frame duration for a frame "i" is stored in delays[i].
frame [ ]	An array of frames stored in frame buffer 18.
frame_delay	The duration of the current frame, for example 1/30 second at a frame rate of 30 frames per second.
frame_size	The size of the current frame, in bits, that has been encoded and stored in VBV buffer 22.
mb_num	The number of macroblocks in a frame (stored in VBV buffer 22) which varies with the resolution of the frame.
original_rate_reduction_fact or	The value of rate_reduction_factor before it is recalculated.
q_scale_type	The first index in to the two dimensional quantizer_scale_tab [ ] [ ] array which ultimately provides a value for quantizer_scale.
quantizer_multiplier	The quantizer_multiplier is an integer, which is used to obtain a new quantizer_scale by multiplying quantizer_multiplier by the value of quantizer_scale in the original macroblocks.
quantizer_scale	The value by which the DCT coefficients of a macroblock are scaled, i.e. the value by which they are reduced to decrease the amount of data transmitted.
quantizer_scale_code	The first index into the two dimensional table, quantizer_scale_tab, which ultimately yields the value of quantizer_scale.
quantizer_scale_inv [ ] [ ]	The inverse mapping of quantizer_scale_tab [ ] [ ], i.e. a table that provides a quantizer_scale_code based upon the quantizer_scale.
quantizer_scale_tab [ ] [ ]	The table which provides the value of a quantizer_scale for a given macroblock, based upon the values of q_scale_type and quantizer_scale_code.
rate_increase	The percentage by which rate_reduction_factor should be increased to avoid overflow of VBV buffer 22.
rate_reduction_factor	The percentage by which the current frame size in bits should be reduced to avoid underflow of the VBV buffer 22.
sizes [ ]	An array containing the size of each frame in bits contained within frame buffer 18.
target_bit_rate	The bit rate in bits/second that is desired between VBV buffer 22 and channel interface 24.
total_delays	The value stored in total_delays is the sum of the time duration of

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	the number of frames stored in window_size frames. The value of total_delays depends upon the size of frame as well as the frame duration. The value of frame duration for a frame "i" is stored in delays[i]
total_sizes	The size of each frame in frame buffer 18 is summed to create the value stored in total_sizes.
vbv_bits	The number of bits present in VBV buffer 22 when the current frame is being processed by encoder 20.
vbv_buffer_size	An 18-bit integer, the lower 10 bits are in the vbv_buffer_size_value in the sequence_header of MPEG-2 and the lower 8 bits are in the vbv_buffer_size_extension in the sequence_extension.
vbv_delay	A value used by VBV buffer 22 to determine timing in accepting incoming frames and transmitting outgoing frames.
vbv_lower_limit	Lower limit on the value of vbv_bits
vbv_size	The maximum size of VBV buffer 22 in bits.
vbv_upper_limit	Upper limit on the value of vbv_bits
window_size	The number of frames stored in frame buffer 18.